DOCUMENT RESUME

ED 080 157 PS 006 636

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TITLE Extended Infant Learning: A Comparison of Two Responses and Two Visual Reinforcers.
SPONS AGENCY National Inst. of Child Health and Human Development (NIH), Bethesda, Md.
PUB DATE Apr 73
NOTE 13p.; Paper presented at the biennial meeting of the Society for Research in Child Development (Philadelphia, Pennsylvania, March 29 - April 1, 1973)

EDRS PRICE MF-$0.65 HC Not Available from EDRS.
DESCRIPTORS *Cognitive Development; *Infant Behavior; *Learning Processes; *Reinforcement; Response Mode; Stimulus Behavior; Technical Reports; Time Factors (Learning); *Visual Stimuli

ABSTRACT

A study was conducted to examine the situational generality of extended learning in early infancy. Ss were 17 infants within one week of eight weeks of age. All but two were Caucasian, and all were from middle-income families. The apparatus consisted of a pressure sensing pillow which, when placed under the infant's head or feet, was sensitive to small pressure changes produced by movement. An electronic control system operated a 15 RPM Hurst Motor or a 25 Watt red light bulb when the infant activated the pillow by his movement. Ss were placed in cribs with their head or feet on the pillow so that when they moved, a counterwas advanced and contingent stimulation was provided. A repeated measures analysis of variance of the baseline data for the first, seventh, and last days of the study indicated no significant change in response rate across the 14-day period. Results indicate that the major increase in response output over a two-week period of conditioning occurs during the first seven days, with attainment of asymptotic level of responding over the last seven days. [Not available in hard copy due to marginal legibility of original document.] (CK)

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Extended Infant Learning: A Comparison of Two Responses and Two Visual Reinforcers[1]

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PS 006636

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Many studies of instrumental learning in infants under three months of age have been single session laboratory investigations aimed at demonstrating learning capacity in young infants (Caron, 1967; Levison & Levison, 1967; Lipsitt, Kaye & Bosack, 1966; Siqueland, 1968; Watson, 1968). It is difficult to assume that the learning demonstrated in these studies is anything but transitory in the absence of more permanent changes in behavior. Experimental manipulations which make assumptions about the retention of information must be carried out over longer periods of time than have often been the case. Several studies which have looked at the course of instrumental learning with the same infants over several days have been reported by Sheppard, 1969; Friedlander, 1970; McKenzie and Day, 1971; Watson and Ramey, 1972; and others. Some of these were lab studies; others were done in the home.

On the response side, there have been studies which have employed head moves as operants and others which have used foot kicks. However, there have been no studies reported which compare different motor responses as operants in instrumental learning situations with young infants. As a matter of fact, few studies have been reported which compare any two responses in the instrumental learning. Sheppard (1969) compared vocalization and foot kicks with one infant in his home over many days, however, this seems to be the only study of this sort.

On the stimulus side, studies (e.g., Lipsitt, Pederson & DeLucia, 1966; Watson, 1969) have used flashing lights or geometric patterns as reinforcers while others have employed moving stimuli or mobiles to reinforce young infants' responses (Rovee & Rovee, 1969; Watson & Ramey, 1972). However, little, if any data have been reported on the relative efficacy of different visual stimuli as reinforcers in instrumental learning situations with young infants. Thus, while the primary purpose of this study is to examine the situational generality of extended learning in early infancy, the particular stimulus and response contrasts employed will provide data relevant to the comparison of visual reinforcers and the comparison of motor responses as regards their functioning in instrumental situations in general. The sense of extended learning which is meant is acquisition of a motor response beyond one or two sessions.

METHOD

Subjects: The sample consisted of 17 infants within one week of 8 weeks of age. All but two were Caucasian and all were from Middle Income families. Subjects' names were selected from the birth records of the City of Berkeley, California, and any infant with any reported complication was screened out. Parents were contacted by telephone and asked to participate in a "learning" study although the expectations of the outcome were never mentioned.

Apparatus: The apparatus consisted of a pressure sensing pillow which, when placed under the infant's head or feet was sensitive to small pressure changes produced by movement. An electronic control system operated a 15 RPM Hurst Motor or a 25 Watt red light bulb when the infant activated the pillow by his movement. The motor and light were mounted on a stand which was placed next to the infant's bed, and allowed a multi-colored mobile to be hung from the motor or a polka-dotted translucent umbrella to be suspended from the light. See Watson (1971) for an illustration of the apparatus. The mobile or umbrella

was suspended 15 inches from the infant's head at the beginning of each session.

Procedure: The study was conducted in the infants' homes by their parent (s). Subjects were placed in their cribs with their head or their feet on the pressure sensing air pillow such that when they moved their head or feet, a counter was advanced and contingent stimulation was provided. The contingent stimuli consisted of either a 1/4 rotation of the mobile or illumination of the patterned umbrella suspended over the infant. Each subject was placed in this contingency stimulation situation daily for ten minutes each day for two weeks by the parent. In order to measure changes in activity for the non-reinforced response, baseline measures were recorded on the first, seventh and fourteenth day of the two week period. Thus, infants reinforced for head movements also had ten minute sessions without the contingent stimulus present with the pillow under their feet on the three baseline days. Similarly, infants reinforced for foot movements had baseline measures taken for head movements. Total responses for each ten minute session were recorded automatically on digital counters inside the apparatus. This data was transferred daily to data sheets by the parents who conducted the sessions. In addition, the time of day of the session was recorded as well as exact times of starting and ending. Mothers, who served as the experimenters in this study, were given a step-by-step set of procedural instructions in conducting the sessions and a short training period.

On the first and last days when the experimenter delivered and picked up the apparatus, the experimenter conducted the session when possible. First he demonstrated the procedure to the parent (s) without the infant, then he conducted the baseline period and then, if the infant was still in a good state (i.e., alert and awake and non-fussy) the first conditioning session was run

with a ten minute break. On the last day, when he came to pick up the apparatus, the experimenter conducted the two sessions. In about half the cases, it was not possible for the experimenter to conduct the session and so the mother was asked to conduct these sessions; but comparison of experimenter run sessions with mother run sessions on the first and last days showed that there were no differences in the performance of the infants.

RESULTS

A repeated measures analysis of variance of the baseline data for the first, seventh and last days of the study indicated no significant change in response rate across the 14 day period. In addition, there were no initial differences in baseline responding on the first day between the four groups.

Insert Figure 1 about here

A repeated measures analysis of variance with sex, response and reinforcer as between factors and days as the within factor was performed on the daily response scores. This analysis yielded a significant main effect for days ($F=2.26$; $df=13,48$; $p < .01$) and a marginal main effect for response ($p < .055$). Inspection of the data suggested that there was a greater increase in responding during the first week than during the second week. None of the other effects approached significance. The marginal main effect for response indicated that foot moves were higher than head moves.

Insert Figure 2 about here

In order to test for this apparently greater responding during week 1, separate analyses were performed for each of the two weeks. The main effect for trials

was significant over the first 7 days ($F=2.33$; $df=6,48$; $p < .05$) but not significant over the second 7 days. The average change in response for the first week was from 9.8 activations per minute on the first day to 12.1 on the seventh day while for the second week response rate remained fairly stable at around 12 activations per minute. A marginal main effect ($p < .062$) for response indicated that foot moves were higher than head moves.

However, the analysis for days 8-14 revealed a marginal main effect for response in which foot moves exceeded head moves ($p < .085$) and significant interaction for the Response X Reinforcer X Days ($F=3.00$; $df=6,48$; $p < .01$) and the Sex X Response X Days ($F=3.23$; $df=6,48$; $p < .01$) interactions. Figure 3 illustrates the Response X Reinforcer X Days interaction.

Insert Figure 3 about here

In this figure you can see the Head mobile group as showing the lowest rate of responding for both weeks although there is evidence of an increase during each week with a drop in the middle. There is a lot of variability from day to day which makes interpretation of this interaction difficult. It appears that the Foot response groups are generally higher than the Head response groups.

For the Sex X Response X Days interaction the males whose Head moves were reinforced showed the lowest level of responding while the males whose foot kicks were reinforced showed the highest level with the two female groups somewhere in the middle.

Insert Figure 3 about here

Figure 3 also shows that there were quite marked differences in responding on the first session of conditioning. The first day's responses

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were subjected to a Sex X Response X Reinforcer ANOVA. The results of this analysis revealed a significant main effect for Response ($F=6.76$; $df=1,8$; $p < .03$) and a significant Reinforcer X Response interaction ($F=6.52$; $df=1,8$; $p < .03$). Inspection of the means on which this result is based revealed that infants provided with a mobile which they could activate with their foot kicks produced a mean of about 14 responses per minute during the first day while infants who activated the mobile with their head movements produced only 6 responses per minute. The infants in the two light conditions did not differ, each producing about 9.5 responses per minute.

DISCUSSION

The present results indicate that the major increase in response output over a two week period of conditioning occurs during the first seven days with attainment of an asymptotic level of responding over the last seven days. Given that one might expect the greatest amount of acquisition to occur on the first day, it is noteworthy perhaps that responding continued to increase beyond that point for all subjects. It is conceivable that this might represent a group effect with different subjects reaching asymptote at different points during the first week. However, inspection of the individual subjects' learning curves shows that for almost all the subjects, the increases in responding were gradual. It would, of course be interesting to know what sort of responding was going on during each ten minute session. Studies presently going on at Berkeley and at the Kennedy Center Infant Laboratory at George Peabody College are collecting data with apparatus that permits analyses of response curves within as well as across days.

In comparing the present results with those of Watson and Ramey, it should be noted that the Head-Mobile group replicates the Experimental group in the former study. And while the present study did not employ separate control

groups to account for the possible arousal value of the stimuli or changes in state across time, the previous study by Watson and Ramey did employ appropriate controls. The virtual identity of basic methodology between the two studies justifies, we believe, the omission from our replication study of specific control groups. The control subjects from the previous study showed no increase in responding across the two weeks and provide satisfactory evidence to preclude alternative explanations for the increased responding in both studies under contingent stimulation. In addition, the finding that the infants in the present study did not show any changes in responding during the non-reinforcement sessions on the first, seventh and fourteenth days supports the contention that learning was demonstrated beyond a single session. The non-reinforcement sessions also demonstrate that reinforcement effects were specific to the response being reinforced during conditioning.

The results which relate to the comparative efficacy of two reinforcers on two responses strongly imply that extended learning can arise in a variety of instrumental situations; that is, the type of reinforcement and the type of response requirement can affect the course of extended learning. The Response X Reinforcer interaction for the second seven days implies that both stimulus events--light and mobile--are effective as reinforcers. It is also implied that each of the motor responses--head and foot--movements can be brought under operant control using contingent visual feedback events.

With specific reference to the reinforcer and response comparisons, it should be evident that the results for the first conditioning session alone would lead to false conclusions about the relative efficacy of the two reinforcers on the two responses. The conclusion for the first day of conditioning would be that a mobile is most effective in reinforcing foot kicks and least effective in reinforcing head moves while a light is equally reinforcing

for both responses. In considering the remainder of the conditioning days, it becomes evident that the mobile is not as effective a reinforcer for head moves as the other Reinforcer-Response combinations.

While the explanation for this is not readily apparent, it is possible that visual stimulation which evokes attention might interfere with head move responses on which the reinforcement is contingent. When infants attend to visual stimuli, there is often a quieting effect and especially a tendency to fixate the source of stimulation and thus restrict head movements (Bruner, 1970). It might be reasonable then to assume that visual reinforcement of foot moves might result in higher rates of responding than visual reinforcement of head moves. The present study does not indicate clearly that this is the case. Even if it were, it would be hard to see why a moving stimulus would be less effective in reinforcing head turns than a light. Resolution of these alternate explanations will demand monitoring of attentional responses during conditioning. It may be that a moving stimulus has higher elicitation value than a change in illumination and thus inhibits head movements to a greater extent. Several studies in our laboratory at Peabody have begun to investigate the relationship between attention and instrumental conditioning using visual reinforcers. Given the current state of the infant conditioning literature and questions raised by the present study, it is evident that further research is needed to explicate the role of attention during learning if we are to continue to utilize contingent sensory stimuli in infant learning.

Overall, the results of the present study strongly support the notion that learning in early infancy can be an extended process measurable in a variety of response-reinforcement situations. The importance of the demonstration of extended learning may be in the fact that infants in their natural environment are subjected to contingencies from the inanimate as well as the social environments

which occur day after day and allow for the building up and maintenance of response strength over an extended period of time even as early as eight weeks.

The progressive and incremental learning across days in an instrumental situation carries the important implication that the learning of one day is retained and integrated with experience on succeeding days. This process is a basic assumption of learning-type explanations of early human development, such as that espoused by Bijou and Baer, yet it has seldom been the focus of empirical research. The findings of this study imply that extended learning may progress in significantly different ways depending upon the reinforcements and responses involved. Yet the data leave little doubt that the capacity for extended learning is functional in many situations and that it is a capacity well established in the human infant by as early as eight weeks of age.

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1. This research was supported in part by National Institute of Child Health and Human Development Grant HD-00153 while the first and last authors were post-doctoral fellows at the University of California, Berkeley. The authors are grateful for the helpful comments and criticisms offered by Steven Friedman. Also, special thanks to the staff of the Health Department, City of Berkeley.

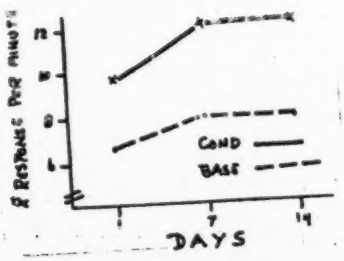

Figure 1

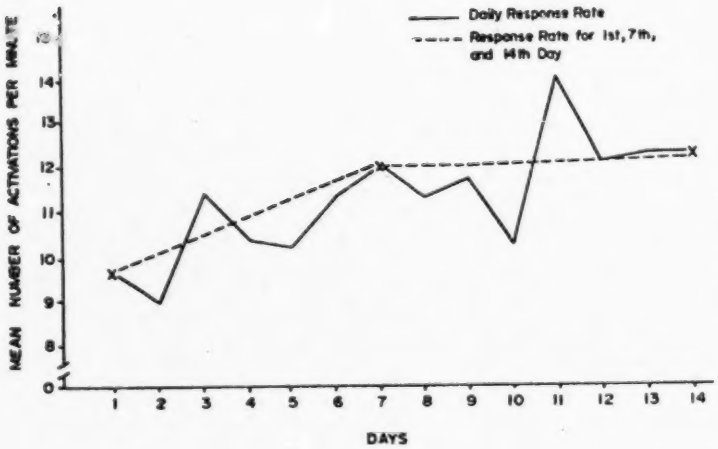

Figure 2

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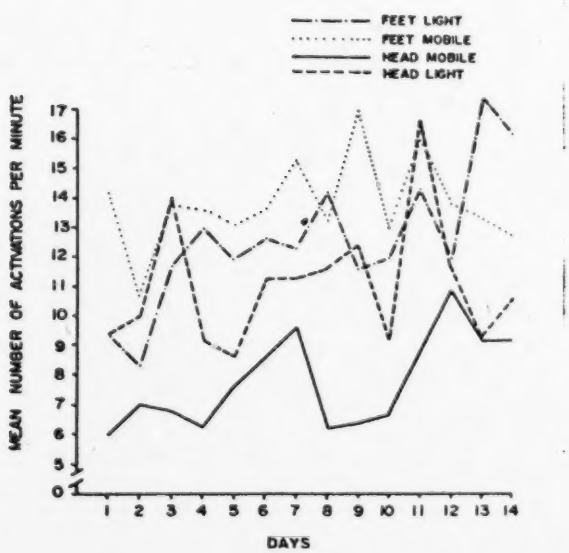

Figure 3